Sunflower Planting and Emergence with Coated Seed

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ABSTRACT

AIR-DISK, plate, and plateless planter metering were compared for sunflower (*Helianthus annuus* L.) seeding accuracy at varying speeds and with different sizes of graded seed plus pelleted seed. When planter speeds with plate metering were increased from 6.4 to 8.0 km/h, the seeding rate decreased by 15 and 35%, respectively, for pelleted and graded seed. There was no speed effect with air-disk metering. Plateless metering was more accurate with large seed than were other systems. Pelleting of small seed increased seeding accuracy up to the levels for medium-sized seed. In a growth chamber study, seedlings from pelleted seed emerged sooner with medium soil water content, indicating that the clay seed coating can increase water imbibition and speed germination under some soil water conditions.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the second most important source of vegetable oil in the world, second only to soybeans [*Glycine max* (L.) Merr.](Cobia and Zimmer, 1978). Sunflower developed as the primary oilseed crop in the Soviet Union and has been widely accepted in Europe, Argentina, and Australia. Since 1966, oil seed sunflower has become an important economic crop in the United States and Canada.

The relatively long and irregular shape of sunflower seed have made them more difficult to plant uniformly than most grain crops. Before the advent of hybrids, open-pollinated sunflower varieties with relatively large seed (11,000 to 15,000 seed/kg) were easier to grade and size for planting (Hagemeister, 1978). Hybrid seed are usually smaller (17,000 to 22,000 seed/kg) and may not fit common planter metering equipment, such as horizontal corn plates, as well as the larger seed. Consequently, the sunflower seed industry and plastic plate suppliers have developed thin plastic plates to be used with a spacer ring for the smaller sunflower seed. The plastic plates are now commonly used with horizontal plate metered planters. The seed industry grades raw seed into size categories 2, 3, 4, and 5 with size 2 seed being the largest (Table 1).

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TABLE 1. SUNFLOWER SEED SIZE CATEGORIES FOR GRADED SEED (HUGES, 1979).

Seed size category	Approximate no. of seed/kg
2	11,000-13,000
3	14,000-15,500
4	17,500-20,000
5	20,000-22,000

Commercial and public research indicates that when plate and seed size are matched, planting accuracy with smaller seed is equal to the larger seed (Hughes, 1979). Johnson and Schneiter (1979) reported that seed size did not significantly affect seedling emergence or seed yield. The higher seed count per unit weight with the smaller sizes of 4 and 5 graded seed offers the grower an opportunity to reduce seed cost.

Another approach for using small and irregular, but viable seed, has been to pellet raw seed with a clay-binder coating for more uniform sizing. The vegetable seed industry has used seed coating in an attempt to improve planting precision with small seed, however, some seedling emergence problems were experienced. Millier and Sooter (1967) reported that the clay coating of commercially processed pellets decreased the rate and total emergence of carrot, lettuce, onion, tomato, and sugar beet seedlings.

OBJECTIVES

We evaluated seedling emergence and planter seed spacing performance with pelleted and non-pelleted (graded) sunflower seed at the USDA Conservation and production Research Laboratory during 1978 to 1980. Our objectivew were to determine (a) the effect of a seed coating on germination with varying soil water content and (b) planter seed spacing performance with pelleted seed as compared with graded seed.

PROCEDURE

In the study, we compared seedling emergence in a controlled temperature chamber and planter performance both on a sand test track and in the field.

Seedling Emergence

For seedling emergence evaluation, both pelleted and regular graded Imperial 903 hybrid* were placed in soil flats with a range of soil water contents from wet to dry. The seed were pelleted by Germain's Inc., Los Angeles, CA.

The soil water contents were 16, 20 and 24% (oven dry basis). The three soil water content levels were

*Mention of a trade name does not constitute a recommendation for use by the U.S. Department of Agriculture.

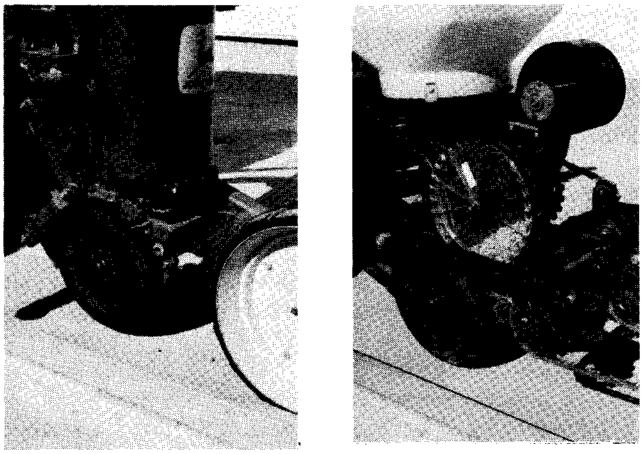

Fig. 1—(a) Unit planter (plate metered).
(b) Unit planter (air-disk metered) with pelleted seed visible behind the translucent metering disk.

approximate wilting point, intermediate, and field capacity for the Pullman clay loam. Crushed ice was added by weight to dry soil and mixed to obtain the desired soil water levels. Forty seeds were placed 2.5 cm deep for each treatment in four replicates. The pelleted and graded seed were placed in alternate, parallel, 10-seed rows in 37- by 50-cm flats. Temperature was maintained near 24 °C during the 7-day test. Seedling emergence counts were made daily from 3 to 7 days after seeding.

Planter Performance

Two planter performance tests were conducted. Test A compared seed placement uniformity for two seed metering systems, operating at three travel speeds, and using both graded and pelleted seed. The two metering systems were compared both on a sand track and in the field.

In Test B, we compared the seed spacing uniformity of three seed metering systems, using four sizes of graded seed and one size of pelleted seed, all at one travel speed. Test B was conducted on the sand track only.

Test A

The sand track test runs were performed with single planter units on a track 5 m long and 0.45 m wide similar to that reported by Nave and Paulsen (1977). The fine sand was 3 cm deep. The sand surface was leveled and smoothed with a broom between runs. The planters were mounted on a tool bar and pulled behind a tractor. The unit planters selected (Fig. 1) were a horizontal plate metered John Deere 71 flex-planter and a vertical air-disk metered White 3400 Plant/aire†. Both planters were equipped with double-disk openers and were press wheel driven. Horizontal (plate) metering and various air-assisted metering devices are commonly used today for row crop planting.

The plate meter uses a spring-loaded, cut-off pawl that removes excess seed from the top of the plate as the cells of the rotating plate pass beneath the pawl. A spring-loaded knockout removes seed from the cells into the delivery tube for gravity drop. The air-disk meter uses both air and gravity for seed metering. The metering disk rotates vertically against the seal of a pressurized chamber under the seed hopper. Air pressure holds the seed in the recesses (cells) as the disk picks up the seed. As the disk rotates past a cutoff, the seed drop by gravity into the seed delivery tube. Planter runs were made at speeds of 4.8, 6.4, and 8 km/h (3, 4, and 5 mph) with four replicates. Planter meter sprocket drive combinations were selected for approximate 15-cm seed spacing. The horizontal metering plates were 24-cell B40-24 for the size 4 graded seed and a 24-cell B10-24 corn plate for the pelleted seed. The Lustran plastic plates are produced by Lincoln Ag. Products of Lincoln, NE.

The metering disks available for the air planter were a 60 cell disk #247393 for small graded seed and a 30 cell disk #247454 for pelleted seed. Both disks were supplied by the air planter manufacturer. Graded seed size 4 and pelleted seed were used in Test A. Seed placement spacing was measured on the sand track and emerged seedling spacing was measured in the field. There were four replications.

Test B

A John Deere 7100 planter, using both horizontal plate and plateless metering seed hoppers, was compared with the White Plant/aire. The plateless metering system consisted of a vertically rotating finger pickup mechanism that delivered individual seeds to a conveyor belt where the seeds were transferred to a gravity drop tube. All seed sizes were tested through the plateless metering mechanism. For horizontal plate metering (described in Test A), sizes 2, 3, 4, and 5 graded seed were metered through plastic plates B020-24, B030-24, B040-24, respectively, and the pelleted seed was metered through the same plate as in Test A. For air-disk metering, the large graded seed (size 2) and pelleted seed were metered through a 30-cell disk #247454 and graded seed sizes 3, 4, 5 were metered through a 60-cell disk #247393. The four sizes of graded seed were products of WAC Seed Co., Hereford, TX. The pelleted seed was the same as used in the other tests. All test runs were made at 6.4 km/h on the sand track. There were four replications.

RESULTS AND DISCUSSION

Seedling Emergence

Seedlings began emerging 3 days after seeding. The percent emergence for each soil water and seed treatment is presented in Table 2. There was no difference in

TABLE 2. SUNFLOWER SEEDLING EMERGENCE WITH GRADED AND PELLETED SEED UNDER VARYING SOIL WATER.

Treatment		Days after seedling			
Soil water dry basis	Seed	4	5	6	7
		Emergence			
--- % ---		%			
16	graded	0	0	0	0
	pelleted	0	0	0	0
20	graded	47d*	72bc	86a	92a
	pelleted	65c	85ab	90a	92a
24	graded	77bc	92a	92a	92a
	pelleted	77bc	95a	95a	95a

* Means followed by a different letter differ significantly at the 5 percent level according to Duncan's Multiple Range Test.

†The authors gratefully acknowledge the assistance of D. F. Wanjura, Research Leader, USDA-ARS, Lubbock, TX, in supplying some of the planting equipment.

TABLE 3. PLANTER SEED SPACING ON THE SAND TRACK WITH PELLETED AND #4 GRADED SEED.

Treatment	Mean spacing, mm	Coef. of variation, %
	Plate metered	
4.8 km/h-pel.	177	54
gr.	122	73
6.4 km/h-pel.	189	70
gr.	131	72
8.0 km/h-pel.	219	77
gr.	180	60
	Air-disk metered	
4.8 km/h-pel.	177	68
gr.	95	76
6.4 km/h-pel.	183	53
gr.	82	72
8.0 km/h-pel.	192	62
gr.	82	64

TABLE 4. FIELD SEEDLING SPACING WITH PELLETED AND #4 GRADED SEED.

Treatment	Mean spacing, mm	Coef. of variation, %
	Plate metered	
4.8 km/h-pel.	229	65
gr.	152	46
6.4 km/h-pel.	238	54
gr.	155	46
8.0 km/h-pel.	241	66
gr.	189	58
	Air-disk metered	
4.8 km/h-pel.	274	41
gr.	125	62
6.4 km/h-pel.	253	53
gr.	149	69
8.0 km/h-pel.	286	63
gr.	158	71

emergence rate between seed treatments in wet soil, which indicates that with ample soil water, imbibition of water by seed was not enhanceed by pelleting. With medium soil water content, significantly more seedlings had emerged after 4 days with pelleted seed (65%) than with graded seed (47%). After 5 days, the difference had narrowed and, by 6 days there was no sigificant difference in seedling emergence. These results contrast with previous work of Millier and Sooter (1967) where pelleting delayed and decreased the emergence of vegetable seeds. The earlier germination with pelleted seed in our tests indicates that the clay seed coating did enhance imbibition of water by seed when the soil water content was limited. All viable seedlings had emerged after 7 days under both the medium and wet soil water treatment. With dry soil (16%), neither graded nor pelleted seedlings emerged though a few of the graded seed did sprout.

Planter Performance Test A

Seed placement data are presented in Table 3 for the sand track tests and in Table 4 for the field test. The coefficient of variation (CV) was used as the main basis for comparison of seed spacing accuracy. The CV (the ratio of the standard deviation to the mean seed spacing) permits a comparison of relative seed spacing accuracy between tests. A relatively low CV percentage significies a high uniformity in seed spacing.

Sand Track: There was no consistent difference in CV that was related to metering method, speed, or seed coating. When the speed was increased from 6.4 to 8 km/h with plate metering, the mean seed spacing increased about 15 percent for pelleted seed and 35 percent for graded seed. This reduction in seed drop at higher speeds is considered typical for horizontal plate metering. With air-disk metering, speed did not affect seed spacing. The seed spacing for air-disk metering with pelleted seed was about double that for graded seed. This was caused by the necessity to use a 30-cell disk to fit the pelleted seed and a 60-cell disk to fit the size 4 graded seed. Also, when metering graded seed with the vertical air-disk, frequently more than one seed would lodge in each cell thus increasing the planting rate.

Field Emergence: The data in Table 4 are presented to show the general increase in spacing of emerged seedlings compared with seed spacing on the sand track. Planter drive-sprocket combinations were not changed between the sand track and field test runs. The average 8:00 a.m. soil temperature at the 5 cm depth was 22 °C during the July 1979 field test. This was about 4 °C below average but did not noticeably slow emergence. Seedling counts were made 7 days after planting. Soil water conditions were excellent because of a previous irrigation.

The mean spacings of seedlings were 20 to 40% greater than spacings of seed on the sand track. The increased spacing of field seedlings, compared with seed drop on the sand track, was attributed to a cumulative effect of seed viability, seed contact with moist soil, and rodent damage to emerging seedlings. For graded seed, the mean seedling spacing increased slightly at 8 km/h planter speed with both metering systems. Seedling spacing, with pelleted seed was not affected by planter speed. With graded seed, there was better seedling spacing uniformity (lower CV) when using plate metering than with air-disk metering.

TABLE 5. PLANTER SEED SPACING ON THE SAND TRACK WITH FOUR SIZES OF GRADED AND PELLETED SEED AT 6.4 KM/HR.

Seed size	Mean spacing, mm	Coef. of variation, %
	Air-disk metered	
2	207	47
3	192	44
4	186	50
5	174	54
pel.	204	48
	Plate metered	
2	196	46
3	196	55
4	235	50
5	177	51
pel.	155	46
	Plateless metered	
2	204	19
3	207	29
4	213	38
5	198	44
pel.	204	35

Planter Performance Test B

Data for planter metering performance on the sand track are presented in Table 5. Each of the three metering systems, evaluated in Test B, were reasonably accurate with coefficients of variation for most test runs averaging less than 50%.

The accuracies with air-disk and plate metering were similar. The spacing uniformity of graded seed increased as seed size increased for all three metering systems, with plateless metering showing the largest increase.

Plateless metering had the highest accuracy (low CV's) of the three systems for all sizes of graded seed and for pelleted seed. This fact is very apparent by the very low CV's, 19 and 29%, respectively, for seed sizes 2 and 3. Seed size had the greatest affect on spacing accuracy with plateless metering, which is illustrated by the relatively wide range in CV's.

For each of the metering systems, the small seed (size 5) had the lowest seed spacing accuracy. In each case, pelleting of small seed improved the accuracy up to the levels for the mid-range sized 3 and 4 seed. The smallest seed (size 5) was more likely to "double up" in the cells of the plateless and air-disk metering systems which caused higher spacing variability. The pelleted seed used in each test of the study were all from the same seed processing lot. We observed during other plantings that when seed was pelleted at different times and from different seed lots; pellet size and shape, coating texture, and coating strength were variable, all of which affected planter metering performance.

SUMMARY AND CONCLUSIONS

When comparing sunflower seedling emergence rates in wet, medium, and dry soil, during a growth chamber test; there were no differences in emergence rate between pelleted and raw graded seed in wet soil. With medium soil water, however, the pelleted seed emerged earlier, but after 7 days there was no significant difference in the number of seedlings emerged. No seedlings emerged in dry soil.

When comparing plate and air-disk metering at different speeds on the sand track, there was no consistent difference in seed spacing accuracy related to type of metering system, speed, or seed type. There was a 15 and 35% reduction in seed drop rate, respectively, for pelleted and graded seed when the speed of the plate-metered planter was increased from 6.4 to 8 km/h. Speed did not affect the seed drop rate for the air-disk planter. In a field test, the spacing of emerged seedlings was 20 to 40% greater than spacing of seed on the sand track. This increased spacing was attributed to the cumulative effects of seed viability, seed-soil contact, and rodent damage.

When comparing air-disk, plate, and plateless metering using different sizes of seed, all metering systems performed satisfactorily but plateless metering was the most accurate—especially with large seed. For each of the metering systems, seeding accuracy was lowest for the smallest seed. Pelleting of small seed increased the seeding accuracy up to the levels obtained with medium-sized graded seed.

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